

CLAIMS

1. A method of producing an actuator for use in an injection arrangement, the method including:

providing a block of ferroelectric material,

cutting and/or shaping the block to a final size to provide a ferroelectric sample which forms the active element of the actuator, the ferroelectric sample having first and second opposing end faces (23), first and second opposing side faces (21), and a stack of ferroelectric layers (16), wherein adjacent layers (16) are separated from one another by internal electrodes (18a, 18b) arranged substantially parallel to the end faces (23) of the sample (14),

subsequent to the cutting and/or shaping step, applying a primary external electrode arrangement to the first and second end faces (23) of the sample,

applying a primary poling voltage to the primary external electrode arrangement so as to polarise substantially the entire ferroelectric sample (14) along a single, first polarisation axis in a first polarisation direction,

applying a permanent secondary external electrode arrangement (30a, 30b) to the side faces of the sample (14) so that the secondary external electrode arrangement (30a, 30b) makes contact with the internal electrodes (18a, 18b),

applying a secondary poling voltage to the secondary external electrode arrangement (30a, 30b) so as to polarise alternate ones of the ferroelectric layers (16) along substantially the first polarisation axis in the first polarisation direction and the others of the ferroelectric layers (16) are polarised along a second, oppositely directed polarisation axis, thereby to polarise substantially the entire sample (14) and avoiding discontinuities in ferroelectric strain throughout the sample (14).

2. A method as claimed in Claim 1, wherein the step of applying the primary poling voltage is applied prior to the step of applying the secondary poling voltage.

5 3. A method as claimed in Claim 1 or Claim 2, including providing a ferroelectric sample (14) in which the internal electrodes (18a, 18b) are grouped into first and second interdigitated sets of electrodes, each set comprising a plurality of internal electrodes.

10 4. A method as claimed in any of Claims 1 to 3, including removing the primary external electrode arrangement from the sample prior to applying the secondary external electrode arrangement.

15 5. A method as claimed in any of Claims 1 to 4, including inserting the sample (14) between a pre-mounted primary external electrode arrangement so that first and second primary electrodes (24a, 24b) contact the first and second end faces (23) of the sample (14) respectively.

20 6. A method as claimed in any of Claims 1 to 4, including applying a conductive film to the first and second end faces (23) to provide first and second primary external electrodes (24a, 24b) of the primary external electrode arrangement.

25 7. A method as claimed in any of Claims 1 to 6, including immersing the sample and the primary electrode arrangement within a dielectric fluid for the duration of the application of the primary poling voltage.

8. A method as claimed in Claim 7, including applying a heating effect to the sample (14) following application of the primary poling voltage to aid evaporation of the

dielectric fluid from surfaces of the sample and/or the electrodes.

9. A method as claimed in any of Claims 1 to 8, in which the primary voltage is no greater than 4 kV.

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10. A method as claimed in any of Claims 1 to 9, in which the secondary voltage is no greater than 200V.